



Beliefs about the 'shape' and continuity of healthy sleep as a function of age



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ABSTRACT

Objective: Treating insomnia includes challenging unrealistic beliefs that may contribute to anxieties and wakefulness. This study explored beliefs about the shape and continuity of healthy adult sleep at different adult ages. **Methods:** Younger ($n = 113, M = 21.4 (2.4)$) and older adults ($n = 110, M = 72.3 (7.7)$) depicted their concept of the normal sleep of both a healthy 18 and 65 year olds. Plots were drawn to show sleep depth and awakenings across the night.

Results: Seventy percent conceptualized healthy sleep as an unbroken U shape and 18 year olds were depicted with deeper sleep than 65 year olds. About 95% of younger adults and three quarters of older adults showed both healthy 18 and 65 year olds sleep without awakenings.

Conclusion: Unrealistic sleep beliefs are widespread, with healthy sleep usually being mistakenly conceptualized as unbroken, even in older adults. Education that awakenings are part of normal sleep may have preventative health implications and reduce sleep anxieties.

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One common misconception is that sleep is one continuous 'down time' where a person falls asleep and stays solidly asleep until the morning. Historical analyses suggest that sleep was not always seen in this way, with Ekirch [1] finding references to 'first sleep' and 'second sleep' (or similar terms) in 58 different sources from the 14th to the 19th centuries. Waking periods were spontaneous and routine and a 1–3 hour waking episode often occurred around midnight. First and second sleep periods were also described by the Tiv people of Africa [1]. Yet in modern times in non-traditional societies nocturnal sleep is seen as a monophasic phenomenon. This is likely to be an artefact of modern lighting [2] and the fact that we typically no longer feel the need to check our sleeping areas for evil spirits or predators. Monophasic sleep is perceived as the normal and 'natural' way to sleep, where breaks in the continuity of nocturnal sleep may be interpreted as signifying difficulty with sleep.

Unrealistic beliefs about sleep continuity may actually contribute to the perpetuation of difficulty sleeping [3]. One unrealistic view is that the 'shape' of a night of sleep is a U shape, where the bottom of the U is the deepest period of sleep and occurs between two wake points at bedtime and the morning. Lack [4] was the first to explore the extent to which this idea is held across the population and devised a simple blank graph on which participants were asked to draw the possible variation of wake, light, deep and very deep sleep across the night.

Using a sample of 250 young to middle age participants Lack found that 70% believed that sleep proceeded in an unbroken U shape. Lack theorized that such a belief may be particularly dysfunctional in older populations where sleep becomes lighter and more fragmented [5]. Older sleepers may become more concerned if they believe that their sleep is abnormal and they may become anxious about the consequences of their fragmented sleep on their overall health [6]. As the normalizing of non-pathological symptoms in the mind of poor sleepers is a key aspect of many psychological treatments [7], it is important to understand the extent to which potentially dysfunctional beliefs about the normal shape of sleep may be present in the community. Given that sleep changes with age it is also of interest to investigate how such beliefs may differ between younger and older adults. Further, do people of different ages have an understanding that sleep becomes lighter and more fragmented with advancing age, even in healthy individuals?

In this study a tool, the Sleep Plot, designed by Lack [4], was used by participants to plot the sleep patterns of healthy adults of two different ages (an 18 year old Sleep Plot and a 65 year old Sleep Plot) across a typical night of sleep. Lack's participants covered a wide age range (38.5 ± 14.4 years). Although he found no difference in the healthy Sleep Plots judged by the younger and older median split of his sample, we wanted a stronger test of the possible age effect of participants. Therefore, participants were derived from two more extreme age groups, aged 18 to 25 years in the younger and aged 60 years or more in the older group.

The rationale for the research included (i) Lack's [4] finding that the predominant characterization of healthy sleep is a U shape, (ii) the lack

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of previous research concerning perspectives on plotting the sleep of one's own age cohort and other age groups, and (iii) the concern that the prevalence of sleep problems in both age groups (older and young adults) may be perpetuated, in part, by incorrect beliefs. The issues to be explored were framed as exploratory research questions, rather than as directional hypotheses:

1. Can the previous finding that the main characterization of the shape of sleep is a U shape be replicated?
2. Do the Sleep Plots differ significantly as a function of the depiction of 18 versus 65 year old's sleep (i.e. plot age) or the age of the respondents (younger versus older adult groups, i.e. age group)? (Here the dependent variables are the depth ratings across 15 time intervals from sleep onset to awakening.)
3. Does the frequency of depicting an uninterrupted U shape versus Sleep Plots with awakenings differ as a function of age group, plot age or sex of the participant? (Here the dependent variables are categorical data relating to plot shape.)

Method

Participants

There were two groups of participants differing in age. In the younger adult group there were 113 (67 female and 46 male) participants between the ages of 18 and 25 years ($M = 21.41$ years, $SD = 2.43$ years). The participants were from the general community and were recruited via word of mouth, workplaces (retail stores), and university lectures. While less than half of the participants were university students no data was collected on this variable. In the older adult group there were 110 (62 females and 48 males) participants aged 60 years and older ($M = 72.13$ years, $SD = 7.71$ years). The participants were from the general community and were recruited via workplaces, community organizations, church, and sporting groups. The response rate across the two groups was 41.3% and this was calculated from the total number of questionnaire packages that were distributed to willing volunteers compared to the number that were completed and returned. No demographic details were collected apart from age and gender and all participants had a sufficiently high level of English language skills to complete the package.

Materials—the Sleep Plot

In the Perceived Normal Sleep Plot [4] participants were asked to plot what they believed the normal sleep period looked like for two different age groups (referred to here as the Sleep Plot). In the Sleep

Plot participants were able to draw waking periods, sleep periods and what they believe happens in terms of depth of sleep across the night. All participants were given two blank graphs with dimensions of 8.5 cm by 17 cm (see Fig. 1) and the following instructions on the first page, with the box shown in Fig. 1 placed below the instructions on the first page.

*This task has two parts: On this page your sleep plot will show us your understanding of the nature of a **normal night of sleep for a healthy 18 year old**. On the next page your sleep plot will relate to the **normal night of sleep for a healthy 65 year old**. Please do this by drawing a continuous line in the box below across the normal night time period. Start the line at the γ mark in the upper left corner, representing the start of the night's sleep, and stop the line at the γ mark in the upper right hand corner of the box, representing awakening in the morning. The dashed horizontal line between awake above and sleep below marks the transition between awake and asleep. The darker bands indicate deeper sleep. With this continuous line indicate your understanding of the progress through the night of a normal sleep of a healthy 18 year old."*

On the following page the instructions, above a blank box as on the previous page, were:

*Now create a sleep plot, using the same starting and ending points (γ) as before, for the **normal sleep of a healthy 65 year old**.*

The scoring of the Sleep Plot for the first three research questions was as described in Lack (2007). The continuous curve for each respondent was assigned one of four different values (0 = wake, 1 = light sleep, 2 = deep sleep, 3 = very deep sleep) for each of 15 half-hourly time points across the night. Thus the horizontal axis of the Sleep Plot shown in Fig. 1 was taken to represent a total of 7.5 h as measured between the two λ symbols. Two different sets of dependent variable scores were yielded for each participant, one for the sleep of a healthy 18 year old and for a healthy 65 year old.

In a more global analysis each plot was categorized into one of three categories. (i) The plot was a U shape whereby the Sleep Plot followed a pattern of light sleep at the beginning of the night going into deeper sleep across the night and then finally coming into lighter sleep until awakening in the morning. The lines had no variations from the U shape that crossed into one of the three colored bands shown in Fig. 1 inconsistent with a continuous U shape. (ii) The plot showed a non-U shape (e.g. at least one transition into a lighter band of sleep followed by a deeper band before ascending into wakefulness) but where there was no awakening depicted. (iii) The plot showed a non-U shape with at least one awakening across the night. Where a plot touched the

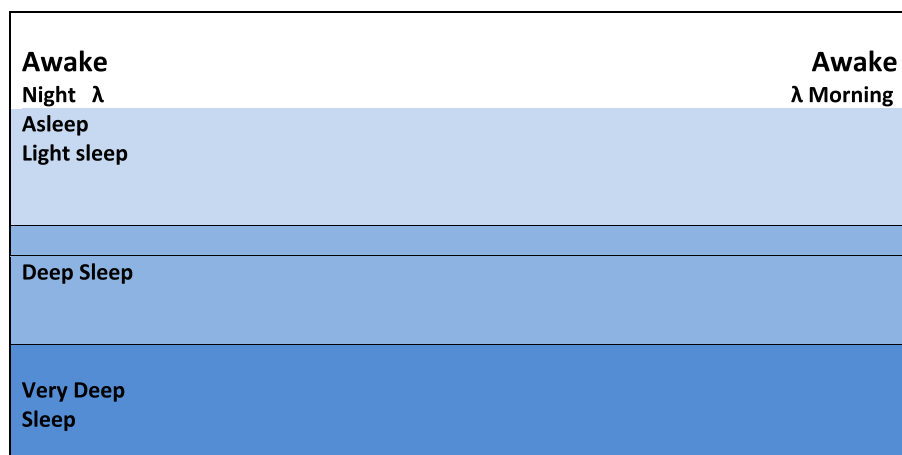


Fig. 1. A blank Sleep Plot, as given to participants.

lower line of the awake band shown in Fig. 1, or crossed the lower line of the awake band before the final awakening, an awakening was considered to have been depicted.

Procedure

Formal ethics approval was obtained from the institution's Human Research Ethics Committee. Prior to data collection all participants gave informed consent after a full explanation of the procedure. Five hundred forty questionnaire packages, with two Sleep Plots in each, were handed out to potential participants recruited from various workplaces, organizations and by word of mouth. (The package also included two questionnaires on beliefs about sleep and sleep-enhancing behaviors, the reporting of which is beyond the scope of the current paper.) Permission was obtained from workplaces and organizations to distribute questionnaires to volunteers. Participants were also asked to take additional questionnaire packages for family members, their spouse or friends to complete who were in the appropriate age range. Participants were first asked to provide their gender and age. On all questionnaires participants were asked to *not* make reference to how items may relate to their sleep in particular, but to the sleep of people in general. Participants mailed back their completed questionnaires and Sleep Plots or handed the sealed envelopes to the researcher. The questionnaires were distributed in late 2010 and early 2011.

Data analysis

To analyze the data obtained, the SPSS Statistics 20.0 program was utilized. For the first research question, confirming that the fundamental shape of the mean Sleep Plot was a U shape, a quadratic component analysis of a general linear model analysis was computed. To investigate possible age effects a two way mixed design MANOVA was performed with one independent variable being *age group* (18–25 year old group compared to the 60+ year group) and the other *plot age* (comparing the depiction of 18 year old's healthy sleep and 65 year old's healthy sleep). The latter independent variable was repeated measures as all participants completed the Sleep Plots for both ages. The dependent variables were the 15 ratings as scored for each Sleep Plot. The assumptions for normality and homogeneity of variances were met. Chi square analyses were used for the final research question exploring the frequencies of different characteristics of the Sleep Plots (e.g. awakenings) as a function of age group and/or plot age.

Results

Table 1 provides the descriptive statistics about the ratings across different time points, as a function of both *age group* and *plot age*. In order to investigate the first research question the four columns of mean values in Table 1 were averaged, representing the 15 mean time ratings across 434 Sleep Plots, where each participant completed two plots. These averaged values were then plotted (see Fig. 2) to obtain a visual representation of the average shape of sleep that was drawn and it can be seen that a clear U shape is yielded. This U shape was indicated statistically with a significant quadratic component analysis ($F(1,215) = 771.6, p < .001$ for the 18 year old's plots and $F(1,215) = 672.7, p < .001$ for the 65 year old's plots).

The two way mixed design MANOVA was significant overall across the 15 Sleep Plot ratings ($F(14, 202) = 142.1, p < .001, \eta_p^2 = .908$). Univariate analyses found a significant main effect for the within subjects variable of *plot age* ($F(1,215) = 51.164, p < .001, \eta_p^2 = .192$) but not for the between subjects variable of *age group* ($F(1,215) = .374, p < .541, \eta_p^2 = .002$). There was no significant interaction effect. The direction of the difference for plot age was such that the 18 year olds were depicted as having deeper sleep than the 65 year olds (see Fig. 3), although the effect size was small and indicated that the 65 year old's plot showed the depth of sleep to differ by about 0.2 of a standard deviation compared to the 18 year old's plot. In summary, the Sleep Plots derived from the young and older participants did not differ. Both groups showed somewhat deeper sleep for the imagined young healthy adult than the old healthy adult.

In the categorical analysis testing hypothesis 3 it was found that 69.4% of all the Sleep Plots showed a single U shape, with no deviations from a quadratic curve and no awakenings. Percentages in these three categories across age group and plot age variables are shown in Fig. 4. Only about 5% of the younger adults thought that the sleep of a healthy person, regardless of whether they were aged 18 years or 65 years, included one or

Table 1

Means (and standard deviations) for each time interval rating on the Sleep Plots.

Ratings	Younger group				Older group			
	18 year old's plot		65 year old's plot		18 year old's plot		65 year old's plot	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	.55	.715	.53	.690	.86	.822	.80	.814
2	1.56	.921	1.46	.847	1.80	1.043	1.54	.967
3	2.05	.880	2.10	.831	2.05	.966	1.89	.906
4	2.23	.804	2.29	.762	2.33	.794	2.15	.859
5	2.35	.835	2.37	.781	2.53	.727	2.32	.838
6	2.50	.779	2.38	.770	2.62	.664	2.40	.759
7	2.56	.660	2.36	.791	2.60	.695	2.39	.792
8	2.57	.686	2.32	.771	2.53	.788	2.16	1.011
9	2.56	.687	2.31	.791	2.52	.845	2.13	.924
10	2.56	.631	2.16	.811	2.49	.812	2.10	.849
11	2.42	.657	2.02	.843	2.50	.741	2.03	.833
12	2.19	.751	1.77	.849	2.25	.830	1.80	.880
13	1.86	.814	1.62	.872	2.03	.822	1.59	.784
14	1.58	.929	1.22	.890	1.66	.863	1.31	.729
15	.76	.852	.59	.749	.83	.803	.64	.687
Mean	2.02		1.83		2.10		1.81	

Note: the Sleep Plots were scored on 4 points across 15 time intervals. 0 = awake, 1 = light sleep, 2 = deep sleep, 3 = very deep sleep.

more episodes of wake. This was in contrast to the Sleep Plots completed by the older adults, where about 23% thought that healthy sleep contained an awakening. A 2×3 chi square test was conducted comparing the older and younger age groups (with plot age combined) across the three Sleep Plot categories (as shown in Fig. 4) and a significant difference was found ($\chi^2 = 41.01, df = 2, p < .001$) between the age groups with the older participants more likely than the young participants to include an awakening as part of a normal sleep pattern. A further chi square test found no significant difference between the two plot ages completed by all participants (i.e. with older and younger age groups combined) ($\chi^2 = 1.48, df = 2, p > .05$). Two chi square analyses were conducted to determine if males and females differed in their characterization of sleep in the Sleep Plots. No significant sex differences were found across the three categorizations for the 18 year old's plot ($\chi^2 = 0.78, df = 2, p > .05$) or the 65 year old's plot ($\chi^2 = 0.91, df = 2, p > .05$).

About a fifth of the older group were plotting the sleep of a healthy person who was aged older than they were at the time of participating and thus their depiction did not reflect their lived experience. For example, a 62 year old was drawing the Sleep Plot for a person aged 65 years. In view of this, two post hoc analyses were conducted to determine if this may have introduced a confounding element. An independent group MANOVA found that there was no significant difference across the 15 Sleep Plot ratings for a healthy 65 year old's sleep from those aged under 65 years ($n = 24$) and those aged 65 years and over ($n = 85$) ($F(1,93) = 1.74, p > .05$). Further, a 2×3 chi square test was conducted comparing these two older groups for the healthy 65 year old's Sleep Plot across the three Sleep Plot categories (as shown in Fig. 4) and no significant difference was found ($\chi^2 = .713, df = 2, p > .05$).

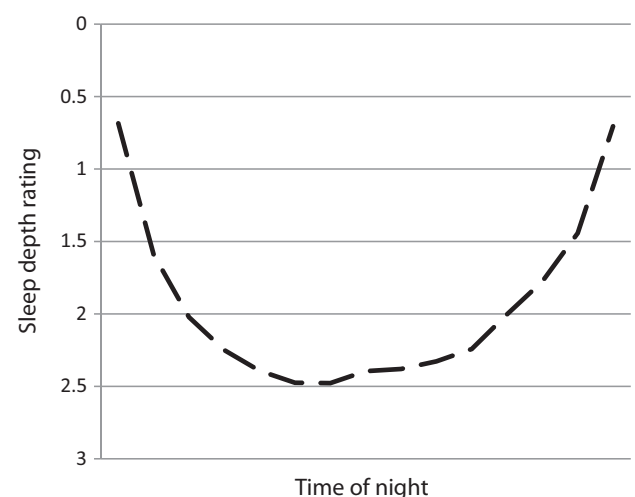


Fig. 2. The averaged Sleep Plot across combined age groups (younger and older age groups) and combined Sleep Plot depictions (18 and 65 year old's healthy sleep) ($n = 434$ Sleep Plots). A rating of 3 represents the deepest sleep.

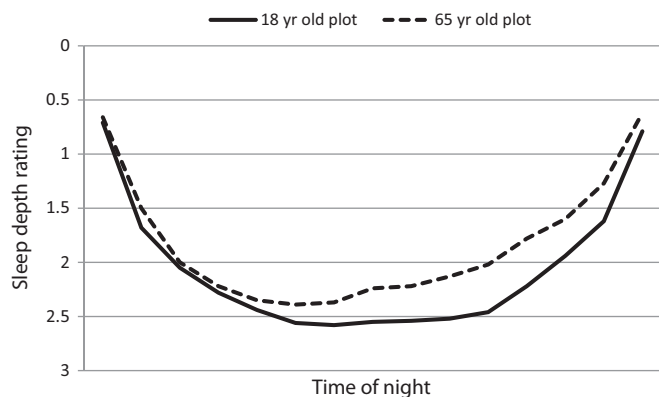


Fig. 3. The 18 and 65 year old's Sleep Plots as depicted by both adult age groups combined ($n = 217$). A rating of 3 represents the deepest sleep.

Discussion

The analysis categorizing the shape and awakenings shown in the plots revealed that about 70% of the sample provided a U shaped Sleep Plot of uninterrupted and deep sleep across the night. These findings are similar to that found by Lack [4] whereby participants plotted the sleep for a healthy young adult and a large majority (70%) of the study (young and middle-aged adults) believed that young, healthy sleep was long and deep (described as U shaped). More than 95% believed that normal young adult sleep would be free of any awakenings. This result is very similar to the present study that shows 95% of younger adults, and about three quarters of older adults believe that healthy sleep across the lifespan includes no awakenings.

The analyses of the Sleep Plots showed that the healthy 65 year old's Sleep Plot had lighter sleep than the healthy 18 year old's Sleep Plot, regardless of the age of the respondent, although the size of the difference was small. The findings of lighter sleep for the 65 year old compared to the 18 year old are consistent with the findings that slow wave sleep decreases with age [5]. The sleep of healthy older people is characterized by an increase in Stage 1 sleep and a decrease in Stages 3 and 4 (deep sleep), resulting in more frequent and prolonged awakenings [5]. Consistent with this lighter sleep with increased age, older adults are more likely to wake to sounds at lower volumes than younger adults [8]. Sleep studies have consistently found that four age related changes in sleep occur. Total sleep time, sleep efficiency, and slow-wave sleep all decrease, while wake after sleep onset (WASO) increases with age, especially after the age of 60 years [5,9]. An examination of arousals across the night in four age groups [9] found that the number of arousals per hour, averaged across total sleep time, increased with age. These

arousals were not all wake periods, with an arousal being specific, abrupt changes in EEG frequency of at least 3-s duration. Teenagers had 13.8 arousals per hour and those aged over 60 years had 27.1. The duration of the arousal was comparatively stable, lasting on average 14.9 ± 2.3 s. Wake after sleep onset (WASO) ranged from 10 min in teenagers to 68 min in the elderly. A more recent meta-analysis [5], where WASO data was examined from 20 studies involving 1012 adults, showed that for all adult age groups, even young adults, some wake time during the night is normal.

It is of interest that the younger and older age groups differed in the extent to which they felt healthy sleep incorporated one or more awakenings. Older adults were somewhat more realistic with about 23% feeling that an awakening could occur in normal sleep compared to only 5% of the younger age group. Interestingly, this was the case for older adults depicting both the sleep of a healthy 18 year old and 65 year old. The inclusion of the older adults in the current study may account for the somewhat higher percentage of respondents overall indicating awakenings (about 14%) compared to the 4% of young and middle aged adult respondents who indicated awakenings in Lack [4]. Lack's earlier finding is consistent with the percent of younger adults showing awakenings in the current study.

Other aspects of sleep beliefs were assessed in the same sample as the current study using questionnaires [10]. Assessments covered beliefs and attitudes about sleep in general as well as activities that were or were not helpful for sleep (sleep hygiene). Older adults had significantly more sleep hygiene knowledge (e.g. about appropriate pre-bed activities and routines) than younger adults but were significantly more concerned about sleep health and the consequences of poor sleep on daytime functioning. The latter finding, combined with the fact that about three quarters of the older adults felt that healthy sleep for a person their age did not include awakenings, suggests that many older adults may be unnecessarily worrying about how normal their sleep is and its impact on day activities. Compared to younger adults, older individuals may be over-anxious about the daytime consequences of what may be a normal level of awakenings during the night. Whether or not such anxiety may be a contributor to poor sleep in older people warrants investigation of, for example, the effect of basic education about normal sleep on subjective sleep quality and sleep-related anxiety. This point has recently been succinctly made as follows: 'In modern times it can be very reassuring for people experiencing poor sleep to know that broken sleep, however, unsatisfactory it might seem, is entirely natural' [11, p. 295].

This study with both younger and older adults, in conjunction with that of Lack [4] with middle aged adult participants, suggests that a large majority of these samples covering the full adult age range have incorrect beliefs about normal, healthy sleep. This could be dysfunctional for some individuals when these expectations are not met. Nocturnal

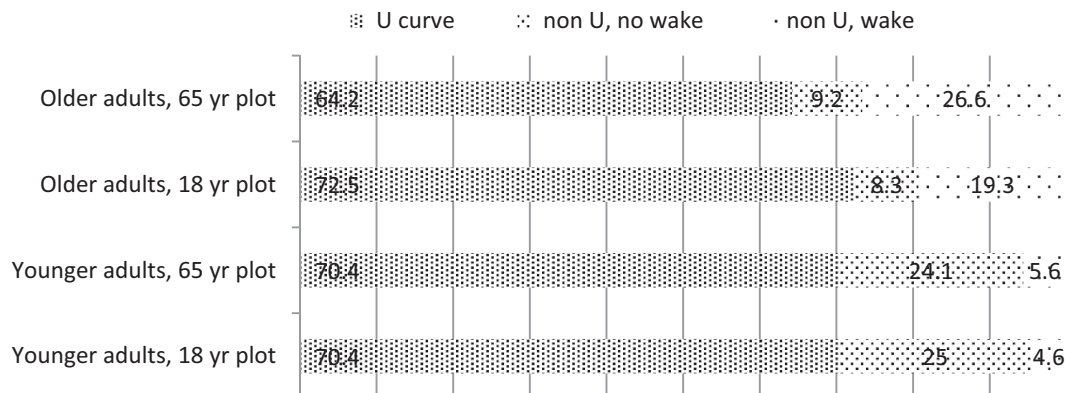


Fig. 4. Percentages of Sleep Plots showing (i) a U shaped curve, (ii) a non-U shaped curve with no awakenings and (iii) a non U shaped curve with one or more awakenings. Data shown as a function of age group and plot age.

awakenings could be considered abnormal and produce concern or distress about their sleep pattern. Older individuals who, in the course of normal aging, are more likely to experience more frequent and/or longer nocturnal awakenings but who still believe that sleep should normally be unbroken may be particularly vulnerable to anxiety about their sleep. Although the greater prevalence of reported insomnia in the aged population [12] is likely to be a result of an interplay of many factors related to normal physiological aging and decreased health status [13,14], such unrealistic beliefs about sleep may be a contributing factor as dysfunctional beliefs and attitudes about sleep are known to impact on sleep quality [15].

Unrealistic beliefs about the continuity of sleep may be related to sleep misperception, which is the mismatch between objectively recorded sleep and self-report. While we do not yet understand the mechanisms underlying sleep misperception it has been argued that various psychological, cognitive, and physiological factors may be at play [16]. The normal brief awakenings that occur across a night's sleep may be a key part feeding into sleep misperception [17]. The findings of the current paper potentially provide support for the role of psychological factors in ongoing sleep misperception. As noted above, individuals who are concerned about their sleep quality because it falls short of their idealized norm of a continuous 'down time', may develop increased arousal related to anxiety about insomnia. The consequences of this increased arousal may vary in degree. In less severe cases the mildly increased arousal may lead to increased awareness of normal, short awakenings whose duration is exaggerated by arousal/anxiety and which are interpreted as problematic. This perpetuates the perception that sleep is poor, although when objectively measured it is normal (i.e. sleep misperception). In the more severe cases, their objectively measured sleep has been influenced by their markedly increased arousal levels across the night and this leads to objective sleep disturbance (insomnia), perpetuated by sleep related anxiety [17,18]. It is possible that all or some of the increased arousal in the latter scenario arises from the mismatch between highly unrealistic expectations as documented by this study, and their perception of their own sleep.

The present study relied on self-administration of blank Sleep Plots for volunteer participants to respond about the healthy sleep of people in general, not their own sleep. The response rate for this questionnaire package was not especially high (41.3%) and it could be argued that people who have a sleep problem may be more or less likely than those with healthy sleep to respond to a questionnaire package about sleep. Unfortunately participants were not asked about the quality of their own sleep, whether they had any psychiatric disorders or whether they were taking sleep medications, as the Sleep Plots were part of a larger package asking about other aspects of their perceptions of sleep in general (e.g. what did they consider helped or hindered quality sleep) and not their own sleep. The Sleep Plots specifically asked about their views of 'healthy sleep'. A comparative Sleep Plot depicting their own sleep would have yielded further insights about possible mismatches between perceived healthy sleep and the lived experience of their own sleep. Future research could be directed at the beliefs of good sleepers compared to those with insomnia about their own sleep pattern and their belief about the normal, healthy sleep pattern for their age group.

While the current study made attempts to recruit a wide range of participants, without a bias to university students, the younger participants were not asked as to whether they had recently studied psychology either at university or secondary school. Previous study of sleep psychology may have resulted in more awareness of the cyclic nature of normal sleep than exists in the general population. However, such an effect appears to be minimal, given that the high percentages suggesting U shaped sleep and low percentages of awakenings in the younger adult group are very similar to the results from a non-student sample of young to middle aged adults in Lack [4]. Since the current study and the earlier one of Lack [4] were samples of convenience without full demographic information apart from age and gender, the results

cannot claim representativeness of the general Australian population. However, the similarity of the results between two studies, administered in two different states in Australia, and the total number of participants ($n = 473$) strengthens its likelihood. A limitation of the current study is the lack of demographic details about educational, cultural and language background and such information would be of interest in any future similar studies. The inter-relationship between sleep-related biological, environmental and cultural factors is a growing area of research interest [19,20], with one cross-cultural study on sleep beliefs finding that some non-Western cultural groups attribute sleep difficulties more to physical phenomenon than psychological [21]. An early bio-cultural model of health [19] has recently been modified with the incorporation of sleep beliefs and behaviors to better inform understandings of adolescent perceptions of healthy sleep [22].

Conclusions and implications

This is the first study to suggest that an unrealistic view about the 'shape' and continuity of adult sleep may be widespread in both younger and older adults in the general community. Importantly, 95% of younger adults and about three quarters of older adults believe that healthy sleep includes no awakenings, whether the sleeper is 18 or 65 years old. However, the participants of this study did understand that younger adults sleep somewhat more deeply than older adults. It is hypothesized that more education about the normal cyclical nature of lighter and deeper sleep across the night, and that the occurrence of awakenings is normal would lead to less anxiety in the community about sleep fragmentation. Although it could be argued that normalizing awakenings at night may deter those with clinically significant insomnia from seeking treatment, we believe that this education would be therapeutic in the treatment of insomnia and, on the whole, help to prevent the development of insomnia in an aging population. These are testable hypotheses worthy of further research.

Conflict of interest

All authors have completed the Unified Competing Interest form at http://www.icmje.org/coi_disclosure.pdf and declare that the authors have no competing interests to report.

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